California Environmental Protection Agency
AIR RESOURCES BOARD

INFORMATIONAL REPORT

Zero-Emission Vehicle Credits for Supplementary Activities:

Stationary Fuel Cells
Hydrogen Infrastructure
Transportation System Credits

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EXECUTIVE SUMMARY

At its April, 2003 public hearing, the Air Resources Board directed staff to report back on the appropriateness of zero emission vehicle (ZEV) credit for stationary fuel cells, hydrogen infrastructure, and station car/carsharing projects (Resolution 03-4). Each of these has the potential to enhance the commercial success of zero emission vehicles. This report explores the role the ZEV regulation could play in promoting these activities. Parallel regulatory and non-regulatory efforts that could produce the same outcome are also discussed. The staff's recommendations are summarized in Table 1 below.

Stationary Fuel Cells

The use of mobile fuel cells in stationary applications could have a modest, positive impact on overall fuel cell development. In particular, staff believes that valuable data and experience could be gained vis-à-vis the durability of fuel cells in sustained, steady-state operation. Expanding the near term market for car-size fuel cells may also stimulate componentry development to some degree. There would not be enough units, however, to affect the overall market for vehicular fuel cells or to achieve significant progress in economies of scale. On the downside, there are many technical challenges facing fuel cell vehicles that are not addressed in stationary applications. These include more strenuous and more variable loads, a wider range of operating conditions, more complex fuel delivery needs and greater packaging constraints, just to name a few. A stationary fuel cell is not fully equivalent to a fuel cell vehicle. Accordingly, as a technical matter, staff is recommending that less than full gold credit be awarded to stationary fuel cells should the Board choose to move in that direction. Staff also recommends capping the total amount of credit stationary fuel cells could earn.

On the policy side, staff is greatly concerned about the precedent of mingling stationary and vehicular controls and wishes to highlight that issue for the Board's attention. To date, California motor vehicle regulations have not allowed stationary source credit -- of any kind -- in lieu of direct compliance with the rules. One could argue that the alternative compliance path of the ZEV regulation is a narrow, tightly controlled universe that has no bearing on any other regulatory matter. But the potential for future erosion is there nonetheless, and is cause for significant caution and concern. The integrity of ARB's vehicle regulations needs to be carefully weighed when considering whether or not to grant stationary fuel cell credit in the ZEV context.

Hydrogen Infrastructure

At the present time, there is more hydrogen available than cars to fuel. In addition, as manufacturers move to the next step of fleet demonstrations (now through 2008) they will either rely on the existing network or acquire purpose-built fueling systems for each demonstration project. Finally, there are multiple issues that still need to be resolved regarding how hydrogen will be delivered (liquid or gaseous), at what pressure, and from which energy source. For these reasons, stimulating hydrogen infrastructure development further at this time seems premature.

Over the longer term as fuel cell vehicles are commercialized and sold to the general public, the availability of accessible, inviting hydrogen refueling stations will be critical. But even then, staff believes ZEV credits are the wrong mechanism to bring about the necessary change. To be truly successful, energy companies will have to get engaged and provide hydrogen-fueling stations when and where they are needed. Since only auto manufacturers receive ZEV credit (not energy companies), awarding ZEV credit targets the wrong sector. Requiring fuel providers or retailers to deploy hydrogen stations would be a more effective way of fostering infrastructure development. The ARB has an existing regulatory mechanism to trigger infrastructure investment from energy providers once the penetration of alternative fuel vehicles exceeds 20,000 statewide: the Clean Fuels Outlet Program. This program was adopted at a time when widespread methanol use was anticipated. Although that did not occur and the fueling requirement was not triggered, the regulation remains on the books and could be relied upon by the Board for future hydrogen infrastructure expansion.

The Board may want to consider whether at-home refueling deserves special attention. At least one vehicle manufacturer is exploring residential fueling systems for private natural gas vehicles. If that is successful, it could potentially evolve to an at-home hydrogen fueling system as well. As a point of historical reference, staff notes that no ZEV credit was provided for electric chargers. Instead, the state relied upon a mixture of public and private investment to install the charging network that exists today.

Transportation Systems

Intelligent, integrated transportation systems are invaluable to ARB's efforts to improve air quality. Coupled with the use of ZEV program vehicles, those systems also support the commercialization of advanced technology. The current incentives in the ZEV regulation for station car/carsharing programs and transportation system credits are relatively generous. However, staff identified two specific areas that could be enhanced. First, staff recommends that neighborhood electric vehicles (NEVs) be allowed to earn transportation system credits. If approved, staff further recommends that the value of such credits be commensurate with NEVs' limited functionality and not be applied to the "alternative path" fuel cell obligation. For all other ZEVs earning transportation system credit, staff recommends that such credits be allowed to count on the alternative path. That would increase their credit value, thus encouraging the use of ZEVs in transportation system projects.

Taxis and shuttles connected to major transit centers (like airports) have the potential to showcase ZEV technology. They may also achieve significant air quality benefits because of their high-mileage driving cycles. Staff recommends further study and solicitation of public comment on the idea of providing transportation system credits for ZEVs used in taxi or shuttle service operations linked to transit.

In 2002, the ARB, the California Energy Commission, and the California Department of Transportation entered into an agreement to support carsharing/station car projects and to strategically place them along "smart mobility corridors." Staff believes this agreement is currently the best tool to collaborate with other agencies and to advance environmentally sound transportation.

CONCLUSION AND NEXT STEPS

Providing ZEV credits for the supplementary activities described in this report may assist with ZEV development and deployment. However care must be taken to avoid providing incentives where no incentive is warranted. It is also important to protect the balanced vehicle production requirements established in the regulation to achieve commercialization.

If the Board decides that additional ZEV credits are appropriate, staff would begin a series of workshops and meetings with affected parties to develop actual regulatory language. The final regulatory proposal would be published for 45-day public comment and would be brought to the Board for consideration by spring 2004.

TABLE 1: SUMMARY OF RECOMMENDATIONS

Recommendation	Positive Attributes	Areas of Concern
Stationary Fuel Cells		
If credit is given: Provide less than full gold vehicle credit (e.g. AT-PZEV) and cap total credit amount Require California-only installations	Potential for improved component development, service life, and cost reductions	Troubling precedent for future vehicle regulations Would reduce number of vehicles produced under ZEV mandate Possible competitive impact to other stationary fuel cell manufacturers
Hydrogen Infrastructure		
Do not award ZEV credits for hydrogen infrastructure at this time Rely on Clean Fuels Outlet Program Continue working w/CaFCP to develop hydrogen infrastructure Consider at-home refueling needs	Takes advantage of ongoing CaFCP work on fueling interfaces, codes and standards Sufficient hydrogen infrastructure available for near term	CaFCP only pledged to continue through 2007
Transportation Systems		
Allow NEVs to earn transportation system credits, tie credit amount to functionality Allow transportation system credits for non-NEV ZEVs to count on alternative compliance path Seek comment on credits for ZEV taxis and shuttle buses Continue to work through ARB/CEC/Caltrans agreement to foster and promote transportation system projects	Promotes projects using short trip, small, low speed vehicles Makes city and full size ZEVs more attractive Visible, high mileage use could help development Integrates clean air, reduced congestion and transportation efficiency goals	Would reduce number of full size vehicles produced under ZEV mandate

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1. INTRODUCTION

In March and April of 2003, the Board considered and adopted amendments to its zero emission vehicle (ZEV) regulation. The modified regulation allows auto manufacturers to choose between "base" and "alternative" compliance paths. The revised base path has similar obligations to those in the prior ZEV regulation (as amended in 2001). Specifically, the base compliance path allows a mix of credits from three categories of vehicles – two percent from pure "gold" ZEVs, two percent from "silver" advanced technology partial zero emitting vehicles (AT PZEVs), and six percent from "bronze" partial zero emitting vehicles (PZEVs). The new, optional, alternative compliance path allows manufacturers to meet part of their pure ZEV requirement by producing a demonstration level, sales-weighted market share of fuel cell ZEVs. Under this path, remaining ZEV obligations may be achieved with a mix of "silver" AT PZEVs and up to six percent "bronze" PZEVs. In addition, up to fifty percent of the fuel cell or pure ZEV obligation may be met with city and/or full function battery electric vehicles (BEVs).

Along with the regulatory changes at the April 24, 2003 hearing, the Board directed staff to report back "on the appropriate process for providing incentives for station car projects, hydrogen infrastructure, and integrating such efforts with related transportation management programs including but not limited to intelligent transportation and smart corridor programs, and on the implications of providing ZEV credits for stationary fuel cells" (Resolution 03-4). Each of these items has the potential to enhance the commercial success of zero emission vehicles. This report is presented to the Board in response to Resolution 03-4. This report explores the role the ZEV regulation plays in promoting these supplementary activities and provides recommendations on whether changes to the regulation are appropriate.

2. STATIONARY FUEL CELLS

The Board asked staff to report back on the implications of providing ZEV credits for stationary fuel cells. In staff's view, the key issues affecting whether to grant such credits are: whether it advances the goals of the ZEV program, the precedent that may be set for other vehicle programs, any negative consequences that may accrue, the overall impact on California, and, if credits are to be awarded, how to arrive at a credit amount that is reasonable and justifiable. Each of these issues is discussed in turn below. Additional background information on stationary fuel cells is provided in Appendix A.

Would Providing Credits for Stationary Fuel Cells Advance Vehicular Fuel Cell Development?

Potentially yes. At this time, fuel cells are at an early stage of commercial development. The proof of concept stage for fuel cells is well demonstrated and steps towards commercialization are underway. However, fuel cells are currently hand assembled with components whose production is still being optimized. Only a limited

number of commercial products are available for stationary source applications; none are available yet for mobile source applications. Increased production of fuel cell stacks for either mobile or stationary applications would improve manufacturing experience and supplier base. Awarding ZEV credits for stationary applications could increase the production volume of fuel cells that can also be used in mobile sources. This would help establish a more stable or predictable fuel cell and fuel cell component supplier market; thereby stimulating continued development in component materials and manufacturing.

Stationary fuel cell applications could also provide additional operating experience by allowing an accelerated test of expected service life. Motor vehicle fuel cells are expected to have a service life of approximately 5,000 hours for the rough equivalent of 100,000 miles. A stationary application operating continuously could accumulate 5,000 hours in approximately seven months of full time operation.

Some downward pressure on costs may occur. Commercial fuel cell vehicles are expected to be more than one iteration away from the current state of technology. The approximate cost of a fuel cell vehicle now ranges from $500,000 to $1 million. Providing incentives for stationary fuel cells has the potential to affect fuel cell stack development and thereby foster reductions in total vehicle cost. Staff believes this effect would be slight, however, given the small number of units involved.

Despite the advantages described above, stationary fuel cell applications would not address all of the issues and challenges facing vehicular fuel cells. This is because the operating conditions of fuel cell vehicles are considerably different than stationary applications. Motor vehicle fuel cell operation is transient, requiring frequent start ups, shut downs, and variations in load. Motor vehicle fuel cells will also be subject to mechanical stress caused by road vibrations and centrifugal forces. Stationary fuel cells will likely operate in steady state conditions, without mechanical stress on the fuel cell. It is important to understand that stationary and vehicle fuel cells are not fully equivalent when deciding what credit, if any, to award the former.

Would Hydrogen Infrastructure be Enhanced by Stationary Fuel Cell Credits?

No. It has been suggested that stationary fuel cell applications will improve hydrogen infrastructure by adding to the network of hydrogen production, distribution and refueling points. However, staff believes that argument is overstated. Stationary fuel cells will likely be placed in two general types of applications: 1) industrial settings where hydrogen is available on-site as a byproduct of existing operations; and 2) premium power or back-up power applications where hydrogen use is limited and may be produced on-site by small hydrocarbon reformers. In each case, the location of the hydrogen is not likely to benefit motor vehicle applications or foster publicly available hydrogen refueling sites. Having said that, any experienced gained from increased use of hydrogen in fuel cells could have some incremental benefit. For example, insights may be gained into the appropriate form of small reformer designs that could be used for home vehicle refueling, hydrogen distribution or stationary on-site storage.

What About Codes and Standards? Would That Effort be Advanced by Providing Stationary Fuel Cell Credits?

Not likely. Since the use of hydrogen and fuel cells in stationary and transportation applications is a newly evolving industry there is a lack of uniform codes and standards in both areas. Deploying fuel cells in stationary applications will require the application and/or development of new codes and standards that are likely be site specific. Staff believes that the development of consistent national and international codes and standards is best served through multi-partner organizations such as the California Fuel Cell Partnership (CaFCP), and by working with organizations such as the American National Standards Institute, the National Fire Protection Association, Underwriters Laboratories, the Institute of Electrical and Electronics Engineers, the International Standards Organization, and the Society of Automotive Engineers. Such work is already underway and does not need any regulatory incentive, in the form of ZEV credits, to proceed.

How Might ZEV Credits Affect the Stationary Fuel Cell Industry?

Unknown. The stationary fuel cell market is still emerging but shows promise in the areas of distributed power generation, portable power, back up or premium power, and in industrial power/heat generation applications. As described in Appendix A, there are several energy-related solicitations at the state and federal level that are incentivizing stationary fuel cell deployment. Several different types of fuel cells are competing for these applications, each with their own advantages regarding cost, operating characteristics and fuels. Given this activity, staff does not believe that the availability of ZEV credits will make or break the stationary fuel cell industry.

With regard to competitiveness within the industry itself, it is important to note that there is only one technology that is used in both the stationary and vehicular markets: the proton exchange membrane (PEM) fuel cell. Other types of fuel cells – phosphoric acid systems, for example – are targeted to stationary applications only. Staff considered whether providing ZEV credits to PEM manufacturers would disadvantage companies that make non-PEM fuel cell products but was unable to reach a definitive conclusion.

What Precedent Does This Establish for Other Motor Vehicle Programs?

A potentially troubling one. To date, California motor vehicle regulations have not allowed stationary source credit -- of any kind -- in lieu of direct compliance with the rules. Instead, ARB's motor vehicle program has focused on the assembly line output automobile and truck manufacturers, fleet average emission standards, and the in-use durability and performance of mobile source products. The success of the Board's single-minded approach speaks for itself. Vehicles of every type are dramatically cleaner than they were three decades ago. Moreover, with many passenger car, sport utility vehicle and light-duty truck warranties now extending out to 15 years or 150,000

miles, this low-emitting performance will be sustained throughout those vehicles' useful life.

If the Board allows ZEV credit for stationary fuel cells, it would potentially lay the groundwork for future requests, challenges, petitions and/or litigation on other motor vehicle regulations. The onus will be on ARB to explain why stationary fuel cells are a special case and why stationary or other non-vehicular credits should not apply. One could argue that the alternative compliance path of the ZEV regulation is a narrow, tightly controlled universe that has no bearing on any other regulatory matter. But the potential for future erosion is there nonetheless and, in staff's view, is cause for significant caution and concern. The integrity of and proven success of ARB's vehicle program needs to be carefully weighed when considering whether or not to grant stationary fuel cell credit in the ZEV context.

Are There Any Other Negative Consequences to Providing Stationary Fuel Cell Credits?

Yes. If auto manufacturers use stationary fuel cell credits to comply with the ZEV regulation it would reduce the total number of ZEVs they are required to produce. Thus, any credits given to stationary fuel cells would result in fewer clean vehicles.

How Would Stationary Fuel Cell Credits Affect California's Interests Overall?

The impact is decidedly mixed. As noted above, stationary fuel cell credits could positively affect vehicle fuel cell development, though in a relatively indirect, unquantifiable way. That result would be useful to California's ZEV vision and goals. However, the integrity of ARB's motor vehicle program could be significantly compromised by mingling stationary and vehicular activities together.

Are There Any Other Practical or Policy Matters the Board Should Consider in Relation to Stationary Fuel Cell Credits?

Yes. If the Board decides to award stationary fuel cell credits, staff believes those credits should be restricted to California placements only. Alternatively, the Board could restrict credits to stationary fuel cells placed in LEV/ZEV states (similar to the treatment of fuel cell vehicle placements in the existing regulation). Staff believes the Board should also cap the total amount of stationary fuel cell credit so that such credits do not overwhelm the ZEV program.

Non-Regulatory Incentives for Stationary Fuel Cells

Staff explored what other incentives exist to support stationary fuel cell deployment to try to gauge whether sufficient incentives already exist. There are and have been various incentive programs that aim to support the development of fuel cells and/or hydrogen infrastructure. Examples are listed in Appendix A.

Summary of Staff Findings and Recommendations

The use of mobile source fuel cells in stationary applications has the potential to foster fuel cell development. Though not an equal substitution for vehicle fuel cell development, stationary fuel cells have a positive impact on several areas of overall fuel cell development. A summary of the parameters considered and expected results are provided in Table 2-1 below.

Table 2-1
Impact of ZEV Credits for Stationary Fuel Cells

Parameter	**Benefit**
Component Development	Positive
Service Life Information	Positive
Cost Reduction	Slight Positive
Automation of Fuel Cell Assembly	Neutral
Vehicle Integration	Neutral
Service Conditions Information	Neutral
Hydrogen Infrastructure	Neutral
Codes and Standards	Neutral
Fuel Cell Industry	Undetermined
Number of ZEVs Produced	Negative
Precedent for Other ARB Motor Vehicle Regulations	Potentially Very Negative

Given these findings, staff is hesitant to recommend ZEV credits for stationary fuel cells. If the Board chooses to award such credits, staff believes the credits should be structured as follows:

- Limit credit amount to AT PZEV silver level rather than pure ZEV gold.
- Limit credit to fuel cell stack technology with demonstrated use in motor vehicles.
- Limit credit to California placements only; or, alternatively, LEV/ZEV states only.
- Cap credits so they do not overwhelm the ZEV program.
- Sunset after the first phase (2005-08) of the alternative compliance path.
- Continue credit only if Expert Review Panel determines stationary fuel cells are still ZEV enabling.

3. HYDROGEN INFRASTRUCTURE

The Board asked staff to evaluate the appropriate process for incentivizing the development of hydrogen refueling infrastructure. Some parties have suggested that ZEV credits should play a role. Staff evaluated that option along with other mechanisms that could achieve the desired result. Since the April 2003 hearing, the issue of home refueling for natural gas and/or hydrogen has also been raised. Staff has not evaluated the home refueling issue in any detail but has included a general discussion of the topic below for completeness. Staff's analysis identified many issues that need to be addressed to plan for mass deployment of a hydrogen refueling stations in California. The practical questions of where, when and how many stations are needed are detailed in Appendix B. The fundamental policy issues discussed here are: what role government should play, how the ZEV regulation fits in, and what the most promising path to hydrogen station development may be.

What is Government's Role in Stimulating the Development of Hydrogen Infrastructure?

As the world leader in ZEV regulations, the State of California has a substantial interest in making that vision a reality. The State and its local governments invested, previously, in the development of an electric vehicle charging network to support the first generation of zero emission vehicles. Free public chargers were installed in state parking garages, at airports, at shopping malls, and at numerous governmental facilities, to support and expand upon the network of at-home chargers that were also available for certain EVs. Unfortunately, battery electric vehicles have not yet succeeded commercially. As a result, the charging network never grew beyond an essentially "fleet-size" arrangement (although a significant number of BEVs were and still are in private hands today). We learned from that experience that a truly successful commercial effort requires growing beyond niche markets and/or fleet paradigms. We also learned that the involvement of energy companies is critical to availability of a dense, convenient fueling network.

Those two lessons put government agencies in a difficult place. The commitment to ZEVs and the associated fueling network is as strong as ever. But the goal of mass market penetration for hydrogen fuel cell vehicles means a substantial transformation of the fuel market is needed as well. That will require substantial capital investment, well beyond the ability of government to provide. Federal, state and local governments can provide but seed money and the right regulatory signals for this effort. The market will have to do the rest.

What Role Could the ZEV Regulation Play?

Only an indirect one. Energy providers are expected to develop and commercialize hydrogen fueling infrastructure. Providing ZEV credit to automakers targets the wrong sector and sends a confusing signal about who the State expects to step forward.

There is also a considerable, intellectual problem about how to structure and value infrastructure credits. As just a few examples, how should the existence of public-private jointly-funded hydrogen stations be treated? What about small, purpose-built refueling devices at auto manufacturers' own facilities? Would they qualify for credit? Despite its best effort and talking over this issue for the past several months, staff has not presented a coherent, workable mechanism for granting hydrogen refueling station credits within the ZEV rule. Happily, staff *was* able to identify a promising alternative. Namely, relying on an existing regulatory mechanism known as the Clean Fuels Outlet Program.

ARB's Clean Fuels Outlet Program

A strong factor in staff's recommendation to not provide ZEV credit to hydrogen infrastructure is the existence of ARB's Clean Fuels Outlet Program. During the mass-buildup of fuel cell vehicle volumes and the commercialization phases that follow, it is important that hydrogen filling stations keep pace with the deployment of hydrogen vehicles. The Clean Fuels Outlet Program requires owners or leasors of a large number of retail gasoline stations to provide a certain number of outlets for clean alternative fuels used by low-emission vehicles. It is triggered when approximately 20,000 non-fleet alternative fuel vehicles using the same fuel are in use state-wide, and sunsets when a specified clean alternative fuel becomes available at 10% or more of the retail gasoline stations in the state. Although the program was not developed specifically with hydrogen fuel in mind, it is sufficiently broad to apply to hydrogen refueling stations.

As the density of hydrogen stations approaches and exceeds 10% of gasoline retail stations, the need for government intervention or assistance with hydrogen infrastructure deployment will decline and might only be needed to address:

- The ongoing availability of hydrogen stations in rural areas,
- The high cost of hydrogen production and distribution relative to gasoline during Stages I and II,
- Programs to work with adjacent states to ensure hydrogen availability along interstate highways leading out of California, and
- Further encouragement for the sale and use of renewable sources to generate hydrogen, clean modes to transport it, and to ensure that source labeling and fuel quality requirements are met.

The Clean Fuels Outlet Program is a valuable component of California's efforts to adopt alternative fuels like hydrogen. It would be appropriate for the program to be reviewed and amended to reflect current program needs as it has been a number of years since it was last done. It is especially appropriate to examine its applicability to hydrogen fueling infrastructure needs. Future Clean Fuels Outlet Program reviews should be done periodically to ensure the effectiveness of the program requirements as hydrogen demand develops.

The California Fuel Cell Partnership

Staff suggests that the California Fuel Cell Partnership is a considerably more effective way of achieving many of the early milestones necessary for creating a hydrogen infrastructure than awarding ZEV credits. ARB is a member of the CaFCP, which is already actively involved in several areas of hydrogen fueling infrastructure development. The members of the CaFCP have successfully placed seven hydrogen fueling stations in California to date (West Sacramento, Richmond, Irvine, Palm Springs area, Los Angeles, Torrance – Honda and Toyota) and plan to have at least three additional hydrogen stations operating in California by the end of 2003 (Davis, Auburn and Los Angeles International Airport). These stations explore different hydrogen production techniques, provide real-world dispensing component evaluation opportunities, and allow partners to work together on vehicle-to-station interface standards and communication protocols. CaFCP members actively participate in codes and standards development throughout the world within a variety of regulatory organizations. ARB should continue to support activities within the CaFCP, especially the development of industry-wide standardized refueling interface protocols, and participation in the necessary codes and standards development for use of hydrogen as a vehicle fuel.

The California (Hydrogen) Corridor

Station density and station locations are critical to establishing a hydrogen refueling network. A potential key role for government to play could be to assist the energy industry with the initial deployment of low-volume "support" hydrogen filling stations along the so-called California Corridor. These stations would initially be spread along selected rural interstate highways connecting the Los Angeles-San Diego region with the San Francisco Bay Area and Sacramento regions, primarily along Interstates 5, 80, and 680/880. The state could direct resources to further study the costs and requirements of this supplemental California Hydrogen Corridor station deployment to connect urban regions. This expanded partnership to address hydrogen fueling might evolve from the existing Partnership Agreement between Caltrans, CEC, and ARB to work together on environmentally sound transportation improvements for California.

Are Additional Incentives Needed?

Yes. In exploring infrastructure needs and deployment issues, staff identified a number of areas where incentives could be used to achieve desired types of hydrogen refueling stations. These included:

- Assisting with the step increase in needed stations as vehicle volumes reach tens of thousands statewide,
- Influencing the placement of stations in "support" locations linking urban areas,
- Encouraging hydrogen production from clean and renewable sources.

The Possibility of Home Refueling

At least one motor vehicle manufacturer is interested in marketing at-home fueling systems for its low emission vehicles. Currently, those plans would affect natural gas vehicles only. However, the same general concept could be applied to at-home hydrogen reformers connected to the same residential natural gas pipelines. Accordingly, the Board may wish to consider whether at-home refueling is a special case deserving of some ZEV credit. The Board could also table this issue until an actual device is identified, fully developed and ready for commercialization.

Summary of Staff's Findings and Recommendations

The deployment of an alternative fueling infrastructure is a key supporting element of the ARB ZEV program that will continue to require significant attention. Without the necessary fueling infrastructure, ZEVs that are necessary for the future of California's mobility and air quality needs will not be possible. Hydrogen vehicles face a daunting refueling infrastructure challenge compared with battery EVs because there is not an existing distribution system to build upon. Ultimately, an extensive hydrogen distribution and refueling system will be needed before the general public will feel comfortable purchasing these vehicles.

Staff recommends that the Board take the following steps to foster the development of hydrogen infrastructure:

- Rely on the existing Clean Fuels Outlet Program, making whatever adjustments are needed for hydrogen applications.
- Continue working closely with the California Fuel Cell Partnership to accelerate the development of vehicle refueling interface standards as well as codes and standards that govern hydrogen storage, transport, and dispensing facilities.
- Explore using the CEC/ Caltrans/ ARB Transportation System Partnership to create a California Hydrogen Corridor as an appropriate mechanism to support stations along interstate highways.

4. TRANSPORTATION SYSTEMS

The Board asked staff to explore enhanced incentives for carsharing and station car projects and integrating them with intelligent transportation and "smart corridor" programs to improve air quality and expand the use of ZEVs. Several approaches to enhance the transportation system credits are explored and addressed in this section. There are many issues to consider when exploring whether the transportation system credits in the ZEV regulation need enhancing. For this reason staff continues to support caps on use of transportation systems credits and a sunset on the availability of such credits. As staff began analysis of this issue, it became clear that some confusion exists about what is meant by intelligent transportation systems. Appendix C attempts to establish some common understanding of what intelligent transportation and smart corridor programs are. It also explores what kind of shared use programs currently exist in California.

Current Incentives

The current ZEV regulation provides additional credits for placing ZEVs, AT PZEVs and PZEVs in a qualifying transportation system. Qualifying transportation systems must, at a minimum, demonstrate shared use and application of "intelligent" technologies such as reservation management, card systems, depot management, location management, charge billing and real time wireless information systems. Projects that link to transit may also receive additional transportation system credits. A project that links to transit and provides dedicated parking and charging facilities at transit stations but is not shared or does not apply intelligent technologies, can also receive credit. The maximum credits that can be earned for each component are as follows:

Type of Vehicle	*Shared Use, Intelligence*	*Linkage to Transit*
ZEV (gold)	6	3
AT PZEV (silver)	4	2
PZEV (bronze)	2	1

There is a cap on the use of transportation system credits in any given model year. Credits earned by ZEVs can be used to satisfy one tenth of a manufacturer's ZEV requirement. Credits earned by AT PZEVs can be used to satisfy up to one-twentieth of a manufacturer's ZEV requirement. Lastly, credits earned by PZEVs can be used to satisfy up to one fiftieth of a manufacturer's ZEV requirement. Transportation system credits may be earned until 2011 and manufacturers may not use transportation system credits to comply with the alternative path.

Possible Additional Incentives

NEV Credits NEVs are specifically excluded from earning transportation system credits. NEVs are "low speed vehicles" that have a maximum speed limit of 25 miles per hour (mph) and can only be driven on roads with a maximum speed limit of 35 mph. An additional approach to providing incentives for carsharing/station car projects would be to make NEVs eligible for transportation system credit. If NEVs were eligible for these credits they would earn a lower credit value due to their limited use. Additionally, such a proposal would include safeguards against abuse of such credits by requiring the intelligent transportation technology criteria and/or linkage with public transit that is currently in the ZEV regulation for transportation system credits. NEVs could provide some positive value to carsharing/station car programs such as lower vehicle cost, increasing the number of miles traveled in clean vehicles, and providing appropriate vehicles for the type of activity--short trips to link with transit. For example, NEVs connected to transit stations can provide a convenient link for commuters whose ultimate destination is greater than walking distance yet still relatively short. Staff recommends that the Board expand the credits to include NEVs placed in appropriate transportation systems. In addition, staff recommends against allowing NEV transportation system credits to be applied to the "alternative path" fuel cell obligation.

Alternative Path Compliance. Another way to expand incentives for carsharing/station car projects would be to allow the transportation system credits to be applied to the gold ZEV requirement for manufacturers that choose the alternative path. The positive result would be to encourage more ZEVs to be used in carsharing/station car projects. However, if credits awarded for transportation systems are expanded, the number of ZEVs produced could be decreased. Therefore, staff strongly recommends that the use of these credits to substitute for Type III (fuel cell) ZEVs be capped. Staff recommends that these credits be limited to the 50 percent battery electric vehicle portion of the alternative path ZEV obligation. Staff would need to perform an analysis to appropriately scale these credits so as not to take away from the goal of fuel cell production. In addition, when you combine allowing transportation system credits in the alternative path with allowing NEVs to earn transportation system credits, NEVs could be potentially replace the production of fuel cell vehicles. In the alternative path requirements, NEVs are excluded from counting towards the fifty-percent battery electric vehicle option in the pure gold category. Again staff recommends that if NEVs are allowed to earn transportation system credits, those credits would not be allowed to apply to the alternative path fuel cell obligation. Instead, they would apply on the base path, and against any silver or bronze obligations.

Other Transportation Types. Transportation system credits could also be expanded to include inter-modal transportation such as taxis and shuttle services using ZEVs. Buses would not be included. The positive benefits would be more exposure of clean cars for the public and an increase of cleaner vehicle miles traveled. Other positive benefits are that taxis and shuttles are in continuous use and often located in highly populated areas where air quality is poor. The original intent of transportation system credits was to have a high standard for encouraging advanced and innovative technology vehicles that

are shared use and link to transit. At this time staff is not aware of any taxi or shuttle services using ZEVs and staff would want to carefully consider and develop any additional flexibility in this area. One possibility would be to allow only fuel cell vehicles to earn such credits and require the linkage to transit for credit. Staff recommends that these vehicles only be allowed to earn the linkage to transit portion of the transportation system credit and not the shared use portion.

Additional Non-Regulatory Approaches

Non-regulatory approaches to providing incentives for carsharing/station car projects can include grants such as the grants offered by Caltrans as discussed in Appendix C. Another non-regulatory approach includes agreements between appropriate agencies to promote such programs. There is a tri-agency agreement between the ARB, Caltrans and the CEC to establish a partnership to introduce environmentally sound transportation improvements for California. This agreement can be used to further facilitate carsharing/station car projects and to strategically place them along "smart mobility corridors."

Summary of Staff's Findings and Recommendations

Staff recommends development of regulations that do not increase the value of the credits for transportation systems, but do expand the types of projects that are eligible for these credits. Staff anticipates returning to the Board with a complete regulatory proposal in spring 2004. In addition, staff recommends continued collaboration with the California Energy Commission, and the California Department of Transportation to support carsharing/station car projects and to place them along smart mobility corridors. Staff's specific regulatory proposals are as follows:

- Make NEVs eligible for transportation systems credit, but do not allow such credit to be applied to the "alternative path" fuel cell obligation.

- Allow other, non-NEV related transportation system credit to count on the alternative path, but cap those credits to the 50 percent battery electric vehicle portion of the alternative path ZEV obligation.

Appendix A – Stationary Fuel Cell Background

The development of a stationary fuel cell market has the potential to positively impact development of motor vehicle fuel cells and the ARB's ZEV program. The following discussion contains background information related to stationary fuel cells. It also contains information related to various incentive programs aimed supporting the development of fuel cells and/or use of hydrogen.

Fuel Cell Stack Market

To date, approximately 1,600 stationary fuel cells ranging in capacity from 10 kW to 200 kW have been built and operated worldwide.[1] There are significantly fewer fuel cells in vehicle applications. The approximately twenty-five fuel cell vehicles now in California represent a large portion of fuel cell vehicles in operation worldwide. If all current large volume vehicle manufacturers choose the alternative compliance path an estimated 250 fuel cell vehicles will be required to have been produced by the end of 2008.

Effect on Hydrogen Supplies

The initial phase of fuel cell vehicle deployment through 2008 will be limited and relatively focused. It is anticipated that the additional demand for hydrogen can be met through current production and distribution methods. While only a limited number of fueling stations will be in place there could be little benefit from additional industrially located fueling stations. Industrial applications will not necessarily be located near areas where the initial fuel cell vehicle fleets will be located or in areas which provide ready public access. To make the transition to hydrogen as a transportation fuel more transparent, refueling sites should be located similarly to existing fueling stations.

Industrial applications primarily receive hydrogen produced by steam reforming natural gas or other light hydrocarbons.[2] To achieve well-to-wheel emission reductions of criteria and green house gas pollutants, hydrogen production will ultimately need to use renewable sources of energy. Providing credits for fuel cells in stationary applications with existing sources of hydrogen would not necessarily help develop new hydrogen production. The long term cost-effective[3] and environmentally beneficial hydrogen fueled economy is dependent on the development of renewable power generation technologies for the production of hydrogen.

[1] Department of Energy, Energy Efficiency and Renewable Energy Web Site: *http://www.eere.energy.gov/hydrogenandfuelcells/fuelcells/stationary_power.html*
[2] Department of Energy, Report: *National Hydrogen Energy Roadmap*, Page 7, November 2002
[3] Department of Energy, Report: *Fuel Cell Report to Congress (ESECS EE-1973)*, Page 41, February 2003

The General Motors Stationary Fuel Cell Demonstration

Hydrogen fueled PEM fuel cells can compete in specific stationary applications such as chemical processes, as demonstrated by the recent announcement by General Motors (GM) and Dow Chemical. GM is planning to utilize 500 mobile source fuel cells (70 kW) in a stationary application at the DOW Chemical facility in Freeport, Texas to produce 35 MW of electricity from the excess hydrogen produced in various operations.[4] This project is projected to start during the fourth quarter of 2003 and run through 2005.

Non-Regulatory Incentives for Stationary Fuel Cells

Following are brief descriptions of some of the non-regulatory incentive programs that have been recently announced or are currently available.

The DOE solicitation titled: *Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project,* provides up to 50% cost share. This solicitation is projected to close September 15, 2003 with awards to be made by 2004 for a 5-year project period. DOE funding for all projects including the testing, demonstration, and validation of hydrogen fuel cell vehicles and infrastructure. The required vehicle and infrastructure interfaces for complete system solutions is anticipated to be between $150 and $240 million. This solicitation provides up to $1,250/kW for stationary vehicle fuel cell applications up to 4.0 MW.

The DOE solicitation titled: *Research, Development, and Integration of Energy-Efficient Technologies in Portable Power, Auxiliary Power Units, and Off-Road Fuel Cell Applications,* provides up to 75% cost share contribution for research and development. This solicitation closed June 5, 2003 with awards to be made by 2004 for up to 3 years. The Off-Road Fuel Cell segment of the solicitation potentially includes construction and farm equipment and the eligible fuel cell range is from 25 to 200 kW. A vehicle fuel cell would fit within this category. Up to $3 million has been allocated for the Off-Road application.

The California Public Utilities Commission (CPUC) offers incentives for the installation of self-generation units, in specified areas, that lessen the electricity load on the power grid. The CPUC program makes up to $125 million per year available to fuel cells as well as other technologies through 2004. Energy sources operating on renewable fuel, between 30 kW and 1.5 MW, are eligible for up to $4.50 per watt (up to 50 percent of the installed project cost). Energy sources operating on nonrenewable fuel, up to 1.5 MW with no minimum size, are eligible for up to $2.50 per watt (up to 40 percent of the installed project cost).

[4] The Hydrogen & Fuel Cell Letter: *Dow Teams with GM in 500 Unit, 35 MW Industrial Fuel Cell Park, World's Largest*, June 2003, Vol XVIII/No.6, ISSN 1080-8019

Appendix B – Hydrogen Infrastructure Background

A key component of the ARB's ZEV program is a hydrogen infrastructure that develops and expands with deployment of fuel cell vehicles. This appendix provides information on how many refueling stations may be necessary at what time frame and in what locations.

Station Density and Timing

There have been few investigations into the threshold number of fueling stations needed to support mass production of hydrogen fuel cell vehicles in California. For very early vehicle introductions in demonstration programs, fleet leases, and with "early adopters," the availability of a nearby station will be necessary, but the overall density of hydrogen stations in California will not significantly affect deployment decisions. By contrast, Stage II of vehicle production will require a step-increase in station deployment.

Table B-1
Hydrogen Vehicle Commercialization Stages

		Vehicle Market	Hydrogen Vehicles In California (Cumulative)	Infrastructure Requirements (# Fueling Stations in California*)
Stage I	Pilot Phase	Mfg. Demonstrations, Early Adopters, & Selected Fleets	1,000+	20-50**
Stage II	Mass Market Intro.	Initial consumer mass-market & Fleets	50,000+	500-1,500 (estimates vary)
Stage III+		Mature consumer mass-market & Fleets	100,000+	1,500-2,500 (estimates vary)

- For comparison, the number of existing gasoline stations in California was approximately 10,300 as of March 2003
- ** California currently has 6 hydrogen stations with ~15 additional stations planned by the end of 2004

During Stages I and II, station construction will be driven primarily by the need for minimum geographical coverage rather than fuel delivery capacity. For Stage III and beyond, as the hydrogen vehicle population is growing at a high rate, the infrastructure challenges will shift towards providing adequate supplies of hydrogen and station delivery capacity.

In studies published thus far that attempt to estimate Stage II station deployment needs, the methodology involves determining what number of hydrogen stations will be required so that a large fraction of potential hydrogen vehicle buyers will have "comfortable access" to hydrogen fueling. As this threshold density of stations is attained, vehicle manufacturers would then be confident in the step up to mass-production of hydrogen vehicles. Several early studies assume that an urban-area hydrogen fueling station density as high as 10% to 15% of the existing gasoline stations will ultimately be necessary to mass market hydrogen vehicles because this is the density where fuel availability becomes a minor consideration for most purchasers of diesel cars. This would amount to deployment of approximately 1,000 to 1,500 hydrogen stations throughout California. This simplification does not address the requirements for stations that would be necessary to link urban areas because diesel is abundantly available on the Interstate Highway system and diesel cars typically have much greater range than early hydrogen fuel cell vehicles. Eventually, it is likely that energy providers will be reluctant to deploy as many hydrogen stations as there are existing gasoline stations in order to help reduce expenditures because hydrogen stations will cost substantially more to build than conventional gasoline stations.

In a recent study by Meliana[5], several different approaches were used to estimate the number of initial stations that would be required before early Stage II can begin. In one of these, the "principal arterial roads approach," Meliana estimates a sufficient number of initial hydrogen stations based on National Highway Classification System data, which categorizes roads according to driving intensity and assumes that initial hydrogen stations would be placed every 20 miles along rural interstates connecting metropolitan areas, and every 10 miles along urban interstates and other arterial roads within metropolitan areas. The results of Meliana's arterial roads approach suggest that a critical mass of about 900 hydrogen stations would be required within California to launch a Stage II mass-market hydrogen vehicle market.

Substantially more research into the requirements of hydrogen fueling infrastructure deployment is needed before energy providers and government agencies can begin to plan for this transition. In particular, more study is needed as to what customers will consider "comfortable enough access" when it comes to hydrogen station location and placement density. The University of California at Davis is currently embarking on a "Hydrogen Pathways" study, a portion of which will specifically address hydrogen infrastructure within the State and provide energy companies and government agencies with a much-needed assessment of infrastructure deployment requirements throughout the transition to hydrogen.

[5] Melaina, Marc. W, *Initiating Hydrogen Infrastructures: PRELIMINARY Analysis OF a Sufficient Number of Initial Hydrogen Stations in the U.S.*, School of Natural Resources and Environment, Center for Sustainable Systems, University of Michigan 430 E. University, Dana Building, Ann Arbor, Michigan 48109, United States

Station Locations

In addition to how many and when, staff also explored where stations will be needed to determine whether incentivizing specific station locations would be beneficial to ZEV implementation. During the buildup of a hydrogen infrastructure, great care needs to be taken to direct capital investments towards stations that maximize the availability of hydrogen to the most probable purchasers of hydrogen vehicles. It is likely that some stations will be "prime" stations, dispensing large quantities of hydrogen, most likely in dense urban areas, while others will be inter-urban "support" stations, providing hydrogen for less frequent refueling events such as long-distance trips. Both prime and support stations are necessary to assure consumer confidence, but it is very unlikely that market forces alone will direct sufficient capital towards the support stations until well beyond the initial mass-market buildup of Stage II. It is very likely that these support stations will initially require some sort of government incentives or assistance if they are to be deployed in time for high volume vehicle sales.

It is not known how important hydrogen stations deployed outside of California are to commercialization success of hydrogen vehicles. It is reasonable to expect however, that additional stations would be installed in other states as hydrogen vehicle technology matures.

Upstream Emissions

Another factor explored by staff was where hydrogen comes from and whether providing incentives for clean hydrogen was valuable to the program. During the early phases of hydrogen vehicle sales, most hydrogen is expected to be generated by the steam reformation of natural gas. This is a catalytic process in which natural gas or other light hydrocarbons react with steam to produce a mixture of hydrogen and carbon dioxide. This mixture is then separated to produce high-purity hydrogen. Wind, solar, and geothermal resources have been demonstrated that can produce hydrogen electrolytically, and biomass can produce hydrogen directly. However, these and other methods for producing hydrogen from renewable and sustainable energy sources without generating carbon dioxide still require substantial development and cost reduction.

All gasoline sold in California has essentially the same upstream emissions because it is derived from the same source, petroleum. The hydrogen that will someday be for sale at hydrogen stations could vary significantly in environmental impact depending on its source. Although it would be desirable to provide regulatory incentives for hydrogen fuel produced from renewable or clean sources, staff continues to recommend against using ZEV credits for this purpose because automakers are not the appropriate party to burden with this responsibility. It may be desirable for consumers to consider the source of hydrogen during their purchase decision. A possible ARB role might be to develop public awareness about the environmental impacts of fuel production and delivery. A goal of this program would be to encourage consumers to choose environmentally beneficial fuels. Additionally, it’s important to continue to monitor the mix of production

sources with an eye towards taking steps to encourage clean hydrogen production from renewable sources either through regulation, incentives, or public education.

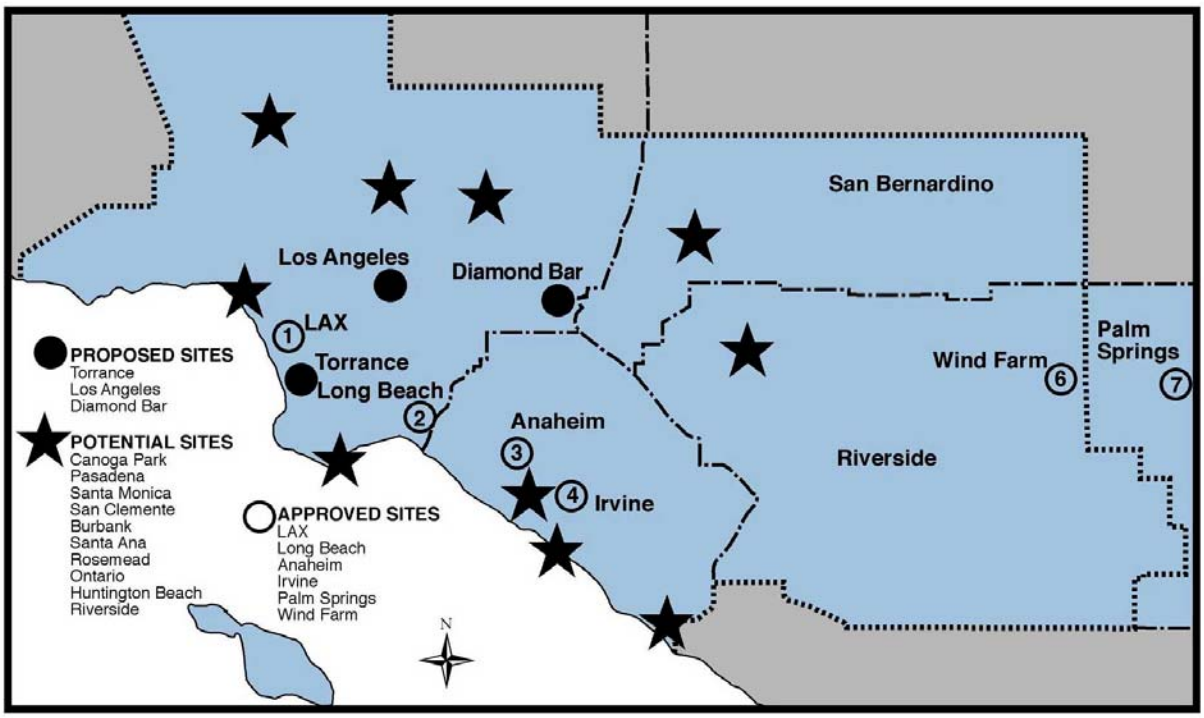
Hydrogen Infrastructure Activities

California Fuel Cell Partnership Infrastructure Activities. ARB is a member of the CaFCP, which is already actively involved in several areas of hydrogen fueling infrastructure development. Its members operate several hydrogen fueling stations, including one at the headquarters facility in West Sacramento. This facility is capable of dispensing hydrogen both as a liquid and in compressed form at 3600 & 5000 psi. The members of the CaFCP have successfully placed seven hydrogen fueling stations (West Sacramento, Richmond, Irvine, Palm Springs area, Los Angeles, Torrance – Honda and Toyota) in California to date and plan to have at least three additional hydrogen stations (Davis, Auburn and LAX) operating in California by the end of 2003. These stations explore different hydrogen production techniques, provide real-world dispensing component evaluation opportunities and allow partners to work together on vehicle-to-station interface standards and communication protocols. Members of the CaFCP actively participate in Codes & Standards development throughout the world within a variety of regulatory organizations. The CaFCP is presently funding a study of facilities that may be used to house hydrogen fueled vehicles, including commercial maintenance facilities, parking garages, and residential garages. This study will examine the modifications, if any, necessary to safely house hydrogen vehicles.

South Coast Air Quality Management District Hydrogen Station Deployments. The South Coast AQMD is presently in the process of co-funding the construction of several hydrogen fueling stations in the Los Angeles region. SCAQMD has initiated the development of eight hydrogen fueling stations and recently approved five additional stations that could be in operation by late 2004 (see map, next page). Each of these early Stage I stations is required to be capable of refueling 10 vehicles per day with potential expansion to 20 vehicles per day. The South Coast District is the only air district working on hydrogen station deployment at this time. However, if federal funds or other assistance becomes available for hydrogen station construction, other air districts may follow.

The leadership shown by both the CaFCP and the SCAQMD in supporting early hydrogen infrastructure deployment illustrates the readiness California has to support early Stage I hydrogen vehicle placements without the need for ZEV credits.

Proposed and Potential Hydrogen Fueling Stations



The California (Hydrogen) Corridor. As identified in the discussion of station density, station locations are critical to establishing an important infrastructure network. A potential key role for government to play could be to assist the energy industry with the initial deployment of low-volume "support" hydrogen filling stations along the so-called "California Corridor." These stations would initially be spread along selected rural interstate highways connecting the Los Angeles-San Diego region with the San Francisco Bay Area and Sacramento regions, primarily along routes Interstates 5, 80, and 680/880.

Initial station spacing would be perhaps 3 or 4 times larger than the Meliana-suggested rural spacing of 20 miles or approximately 60-80 miles between stations. This spacing will eventually need to be reduced to 20-40 miles ahead of Stage II vehicle sales. Station capacity would vary, but support stations could make effective use of extremely small storage capacity stations that might initially only deliver fuel to a few vehicles per day. Permanent larger capacity urban stations will be delivering fuel to 200+ vehicles per day and, as a result, will be much more economical to operate. Rural interstate support stations might be mobile type stations on trailers, or palletized modular design in order to allow easy incremental increases in storage capacity or to facilitate re-deployment in more remote locations as they are replaced by permanent stations late in Stage II or in follow-on commercialization stages. Because of their reduced storage capacity, "support" stations might also be "smart" hydrogen stations that will broadcast real-time status and hydrogen capacity information to nearby hydrogen vehicles and allow reservations or advanced purchase of fuel before a vehicle arrives.

Locations and signage for support stations would necessarily be very conspicuous to build public awareness and confidence ahead of and during Stage II deployment. It might also be advantageous to use Caltrans controlled state land along these interstates to temporarily assist in the siting of these stations.

Selected subsections of the California Corridor are under consideration by Caltrans for designation as “Smart Corridors” that will showcase a variety of advanced, intelligent, and clean transportation technologies. These Smart Corridors will most likely lie directly along the most heavily traveled routes and may also feature multiple modes of transportation. Because the transportation and population density in these regions will be high, hydrogen vehicles will probably be deployed earlier than in other regions, so it is likely that energy providers will choose to, or even compete to deploy hydrogen refueling stations within these project areas even without government assistance. A potential government role within these smart corridors would be to co-locate education/outreach centers to help familiarize the public with hydrogen as both a vehicle fuel and as a means to distribute energy for other purposes.

Smart Corridors might also be good initial locations to begin test and evaluation of “smart” hydrogen stations that broadcast real-time status and hydrogen capacity information to nearby hydrogen vehicles and that would allow reservations or advanced purchase of fuel before a vehicle arrives. These stations might work seamlessly with the navigation systems in future hydrogen vehicles to help drivers plan fueling stops and give directions to these fueling locations. These network/reservation systems may be necessary to insure the successful use of support stations with limited hydrogen storage capacity since the chance arrival of only a few dozen vehicles could fully deplete the station and place it out of commission until its reformer catches up with demand, or until a tanker is sent to refill it.

Appendix C – Transportation Systems Background

Intelligent Transportation

Intelligent transportation is the use of technology to improve transportation services. Examples include electronically paying bridge tolls and bus fares, giving driving directions and steering drivers away from congestion and accidents, and providing traffic engineers with real-time use and road conditions. Intelligent transportation can also include allowing transit buses to travel congestion-free, routing, monitoring and tracking shipments, and telling drivers if there is available parking at the train station. Intelligent transportation is a multibillion dollar industry in California, not dependent upon public procurement projects. Over 90 percent of intelligent transportation products and services projected by 2010 will be sold to individual consumers or commercial customers. The California Alliance for Advanced Transportation Systems (CAATS) puts intelligent transportation into six system categories. [6]

1. *Transportation Management* - surveillance loops, weather sensors, signal preemption, incident management, ramp metering.
2. *Traveler Information* - changeable message signs, internet services, parking and transit information systems, personal communication devices.
3. *Public Transportation* - transit priority systems, fleet management, smart shuttles, computer-aided dispatch.
4. *Goods Movement* - vehicle and goods location and identification systems, weigh-in-motion systems, terminal access improvements.
5. *Electronic Payment* - automatic fare payment systems, electronic toll collection.
6. *Vehicle Control and Safety* - in-vehicle devices such as vision enhancement, obstacle detection, collision warning, etc.; driver, vehicle and cargo condition monitoring.

Virtually every known intelligent transportation application has been implemented or is under consideration in California. Caltrans' future vision is to coordinate these technologies to make California's transportation system even better. This could include such strategies as a statewide traveler information web portal and information phone service, a statewide electronic payment system for transit fares, toll collection, parking fees, bicycle lockers, etc., and an integrated approach to using existing infrastructure, such as providing dedicated bus service on HOV lanes.[7]

Intelligent transportation is much broader than the station car/car sharing projects that are currently receiving credit in the ZEV regulation. Staff supports keeping ZEV credits limited to applications making use of ZEV program vehicles (battery EVs, fuel cell vehicles, AT PZEVs, or PZEVs).

[6] California Alliance for Advanced Transportation Systems, *Intelligent Transportation Systems Deployment Initiatives Project, Pages 1-3, 1999*

[7] California Department of Transportation, *Draft California Transportation Plan 2025, Pages 27-28,* September 2002.

Smart Mobility Corridors

What exactly is a Smart Mobility Corridor? Generally, these are strategically planned areas where various innovative modes of travel and intelligent transportation technology are concentrated. From staff's view, these corridors could help people make clean air choices, by giving them a choice of lower pollution modes of travel and would decrease miles traveled overall. One can envision such a corridor along densely populated areas or connecting densely populated areas. Available transportation modes could include mass transit, shared use vehicles, and various alternative fueled vehicles. Intelligent transportation systems could include real-time signage indicating availability of fueling stations, parking for alternative fuel vehicles, smart card access that links various modes of travel (rapid transit, trains, ferries, buses, shared vehicles). Smart Mobility Corridors can be modal integration of transportation options to improve air quality in California. As discussed in chapter 3, smart corridors may be excellent candidates for focusing efforts to deploy hydrogen infrastructure.

Carsharing and Station Car Projects

Carsharing and station car projects are innovative means of transportation that can improve air quality and mobility. Air quality improves when vehicle trips are reduced by carsharing and station car projects, which provide convenient access to vehicles near home, work and transit. In addition, as some carshare/station car participants become more aware of transportation costs, they may plan their transportation needs more efficiently and ultimately may reduce the number of vehicles they own, further decreasing emissions. Carsharing/station car projects are integral to a partnership agreement between the ARB, the California Energy Commission (CEC) and Caltrans. The goal of the partnership agreement is to ensure timely planning, implementation and research of innovative transportation projects that facilitate modal integration of transportation options and protect the State's environment.
Most shared use vehicle systems are concentrated in densely populated urban areas. There are several descriptions of shared use vehicle systems. Two types of shared use vehicle systems will be described here; carsharing and station car programs. There are also "hybrid" programs that combine both carsharing and station cars.

Carsharing. Carsharing began in earnest in Europe in the 1980's. The most successful carsharing organization currently operating is in Switzerland with nearly 54,000 members and approximately 1,700 vehicles. Carsharing started in the United States in the 1990's. Carsharing generally consists of strategically placed vehicles in neighborhoods available for use 24 hours a day. The vehicles are used for short periods of time. Typically a user makes a reservation, picks up a vehicle, uses it, and then returns it to the same location. Users pay for the amount of time the car was used and/or miles driven similar to car rental companies, except that users also become members and receive a monthly bill. The carsharing organization maintains the vehicles, fuels them, handles scheduling arrangements and obtains insurance. All these costs are shared among the users. Research by Dr. Susan Shaheen (UC Berkeley, Caltrans) indicates that U.S. carsharing organizations are increasingly integrating advanced technologies into their services to facilitate reservations and billing, vehicle

tracking, and overall system management. This helps them improve operations, enhance customer service and reduce costs. [8]

Station Cars. Station car systems consist of vehicles placed at or near transit, used for the final link to work and/or home. They differ from carsharing in that vehicles are used for one-way trips. At either end of the transit link, another user may use the same vehicle. For example, one person drives the vehicle from home to the transit station and someone commuting the opposite way arrives at the transit station and proceeds to work using the same vehicle. There are currently two carsharing organizations active in California. City Carshare, a nonprofit organization started in 2001, has operations in San Francisco, East Bay and the Peninsula and has been highly successful with an estimated 2,200 members and 80 vehicles in 38 locations.[9] They recently expanded to University of California (UC) Berkeley and UC San Francisco making cars available to staff, faculty and students. Flexcar, a Seattle based company that is one of the largest carsharing organizations nationwide, began operations in 2002 in Los Angeles and San Diego. Flexcar may also be expanding in the Bay Area. Lastly, Flexcar, has formed a partnership with Westart/Calstart and Bike Station Coalition, to offer cars and bikes for shared use in Long Beach.

There have also been several successful research carsharing and station car projects: the Zero Emission Vehicle-Network Enabled Transport (ZEV NET), UC Riverside IntelliShare, Carlink I and Carlink II. Each one of these research programs has had certain goals, some focusing on market sustainability, some focusing on intelligent technology and some focusing on both. They've all contributed to the evolution of carsharing/station car programs. Like the station car project examples above, many of these programs are examples of the type of program that would receive ZEV credit when using ZEV program vehicles.

ZEV NET is a not-for-profit venture launched in 2002 between the National Fuel Cell Research Center and the Institute for Transportation Studies at UC Irvine in cooperation with Toyota Motor Sales Inc. Other partners include the City of Irvine, the Orange County Transportation Authority and The Company**.** ZEV NET has zero and low emission vehicles and is working to establish, demonstrate and develop a sustainable station car program model that can be applied to major California regions. In addition, they are integrating stationary fuel cells and solar panels to generate electricity for electric vehicle recharging to establish a true zero emission transportation system. They are also testing intelligent transportation systems such as global positioning systems (GPS), smart vehicle access and wireless networking. Several private companies use the vehicles as well as UC Irvine employees, professors and students with approximately 400 drivers and 50 vehicles.

Intellishare is a carsharing research program that started in 1999 at UC Riverside. The program was set up to evaluate carsharing among several stations located on and near the campus. Twenty five electric vehicles are shared among 350 members consisting of

[8] Susan Shaheen, Ph.D., and Kamill Wipyewski, *Applying Integrated ITS Technologies to Carsharing System Management: A Carlink Case Study,* University of California Berkeley, Innovative Mobility Research, Pages 1-3, 2003.
[9] Mobility Newslink, *City Carshare Moves Ahead*, April-May, May 2003.

faculty, staff and student employees. The program has incorporated intelligent transportation systems for user convenience and vehicle monitoring.

Carlink I was a ten-month carsharing research program started in January 1999, based at the Dublin/Pleasanton BART station in the Bay Area. Partners in the program included the Caltrans, Institute of Transportation Studies-UC Davis, University of California's Partners for Advanced Transit and Highways, American Honda, BART and Lawrence Livermore National Laboratory (LLNL). Twelve compressed natural gas Honda Civics were available to LLNL employees and other members. Intelligent transportation systems were also incorporated. Carlink resulted in a net reduction of an estimated 20 miles per commuter per day.[10]

Carlink II is the second part of the carsharing research program described above. This program started in July 2001 and was completed in June 2002. Carlink II introduced more advanced vehicle reservation, access and tracking technologies. Carlink I partners, excluding BART, paired with Caltrain on this program. There were 18 vehicles and 100 members. Service was provided to commuters using a Caltrain station in Palo Alto as well as employees at or near the Stanford Research Park. Both Carlink programs are described as a carsharing program with a link to transit –a hybrid of carsharing and station cars— with maximized use of the vehicles as an objective.

Grants

In the fall of 2002, Caltrans, the California Transportation Commission, and the California Business, Transportation and Housing Agency announced conceptual approval of a $3.6 million Statewide Carsharing project. Actual funding for the project is still pending. The project will deploy shared use vehicles near transit throughout California, to increase mass transit use, reduce air pollution, reduce land use impacts and improve traffic congestion. The five-year program is split into two phases. The first phase covers two years and the second phase covers the remaining three years. Applications for the first phase are currently being accepted and workshops have been held throughout different regions. An estimated 750 vehicles in shared car applications would be placed in the first phase, increasing to an estimated total of 1,400 vehicles in the second phase. The second phase will require additional funding.

[10] Innovative Mobility Research Group website, Carlink I Research Project: *http://www.innovativemobility.org/research/carsharing_research_p.htm.*

Appendix D – Table of Acronyms

ARB..... California Air Resources Board
AT PZEV..... Advanced Technology Partial ZEV
BEV……Battery Electric Vehicle
CAATS ..... California Alliance for Advanced Transportation Systems
CaFCP ..... California Fuel Cell Partnership
Caltrans..... California Department of Transportation
CEC..... California Energy Commission
DOE ..... United States Department of Energy
EV ..... Electric Vehicle
HOV ..... High Occupancy Vehicle
Kg..... Kilogram
kW..... Kilowatt
MW..... Megawatt
NEV..... Neighborhood Electric Vehicle
PEM ..... Proton Exchange Membrane
psi..... pounds per square inch
PZEV..... Partial ZEV
SCAQMD .... South Coast Air Quality Management District
Type 0 ..... Utility EV, < 50 miles
Type I ..... City EV $\geq$ 50, < 100 miles
Type II ..... Full Function EV, $\geq$ 100 miles
Type III ..... EV, $\geq$ 100 miles plus fast refueling
ZEV ..... Zero-Emission Vehicle